Sept. 22, 1953 W. ARMSTRONG 2,653,022

ANTIINERTIA MECHANISM FOR SLIDING DOORS

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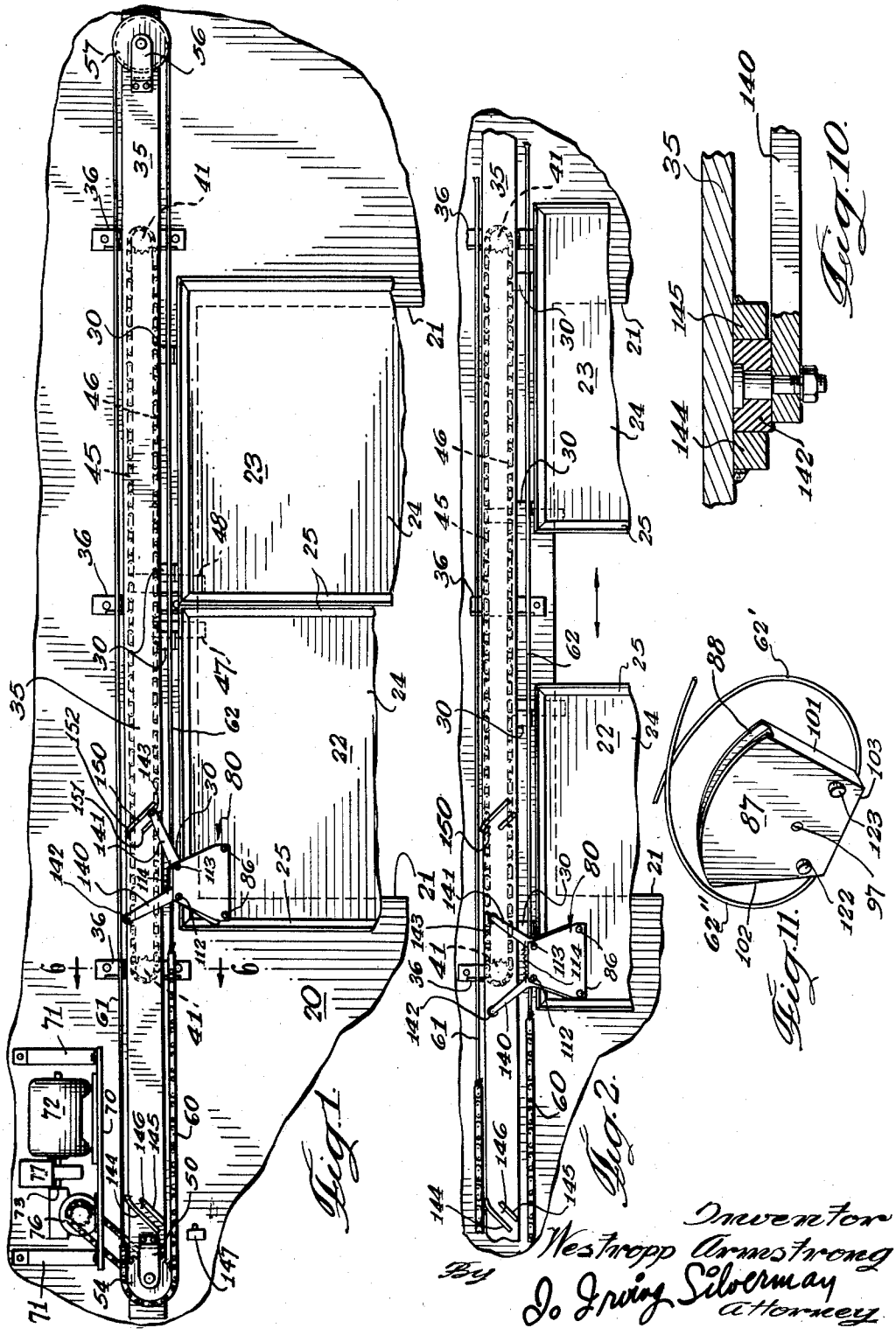


Fig. 1.

Fig. 2.

Fig. 10.

Fig. 11.

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ANTIINERTIA MECHANISM FOR SLIDING DOORS

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Fig. 3.

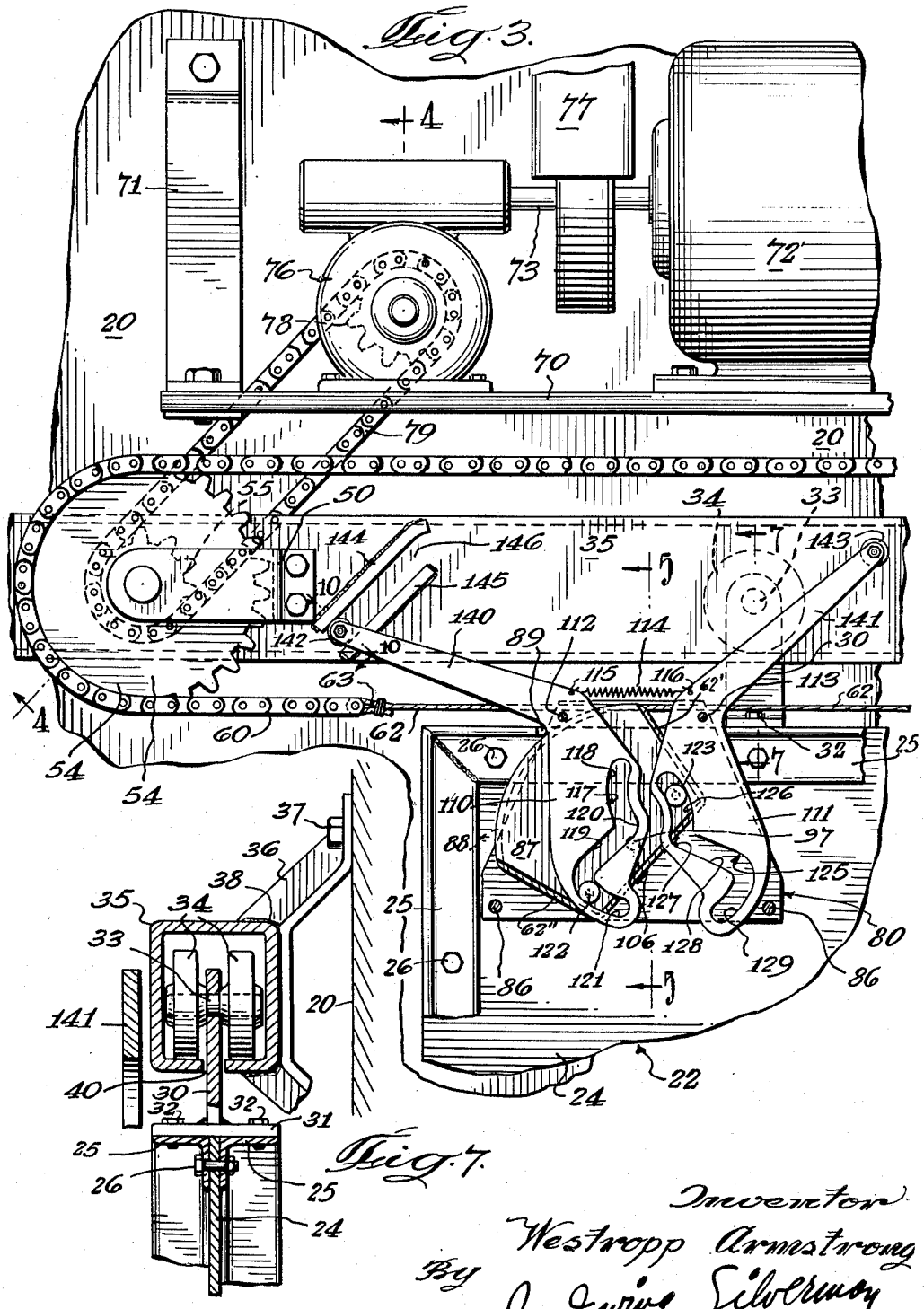


Fig. 7.

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ANTIINERTIA MECHANISM FOR SLIDING DOORS

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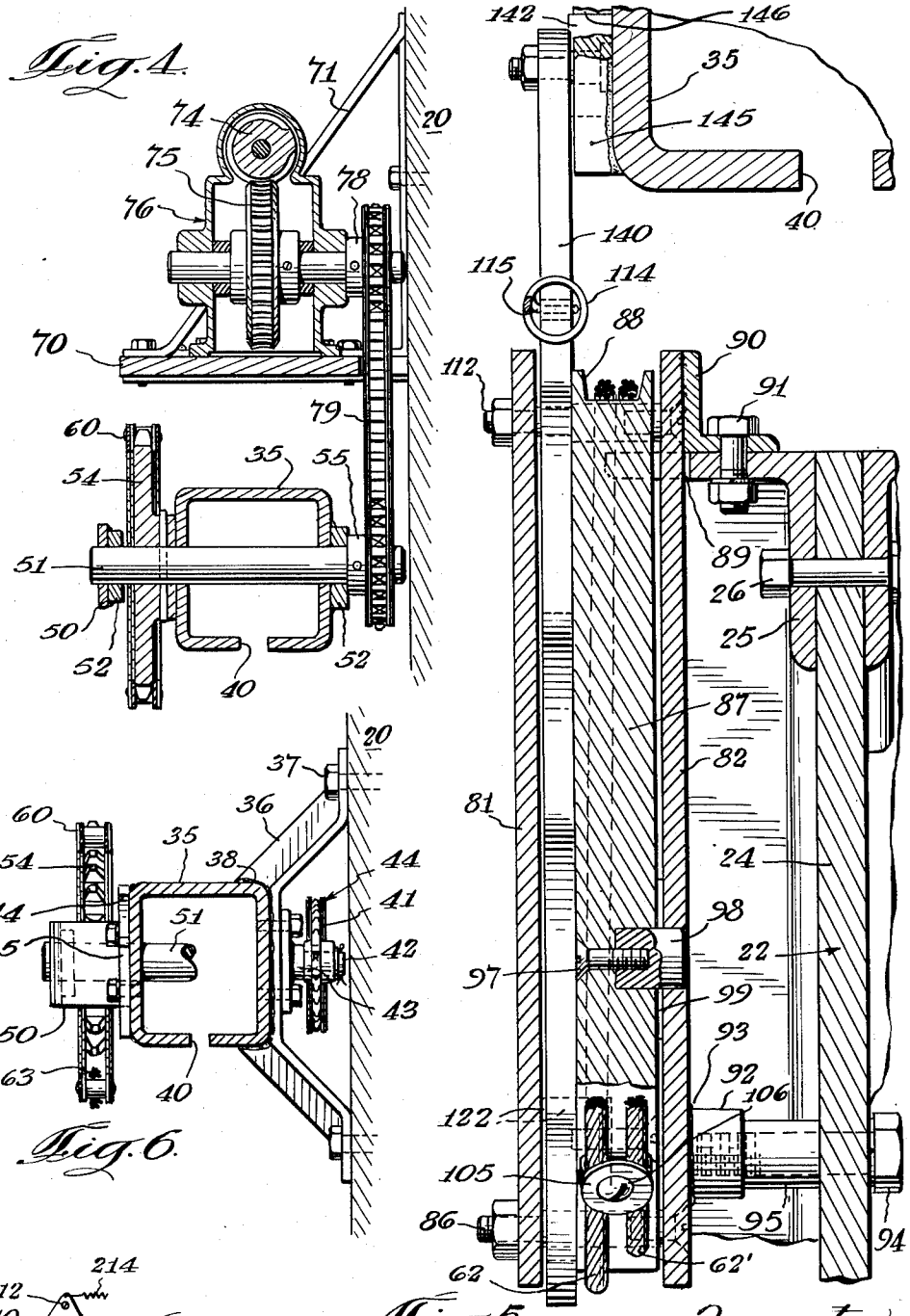


Fig. 5.

Fig. 6.

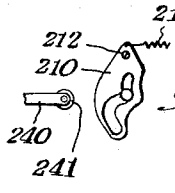


Fig. 14.

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ANTIINERTIA MECHANISM FOR SLIDING DOORS

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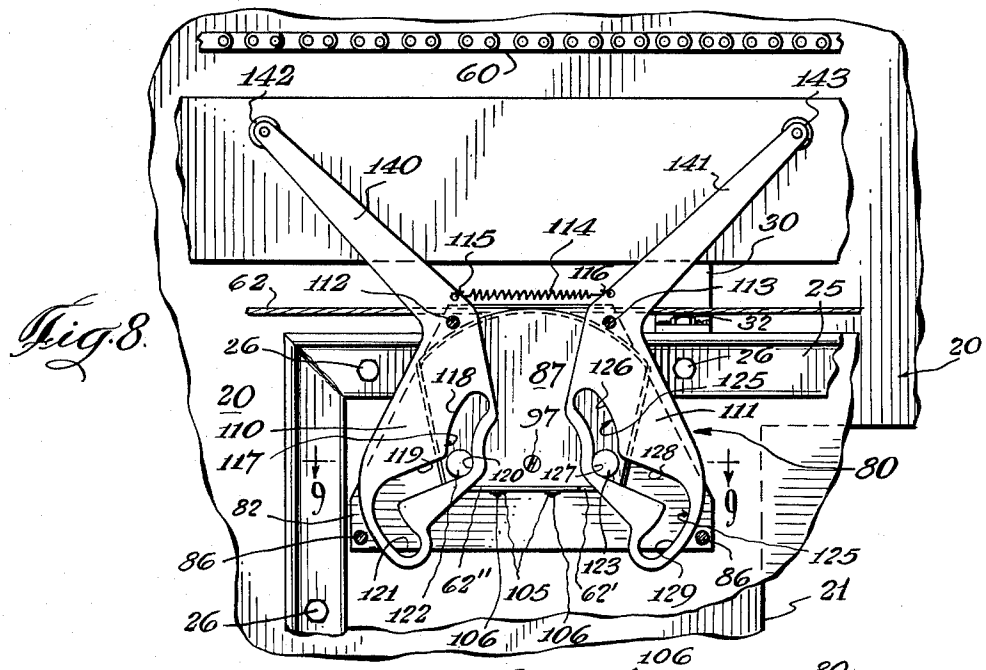


Fig. 8.

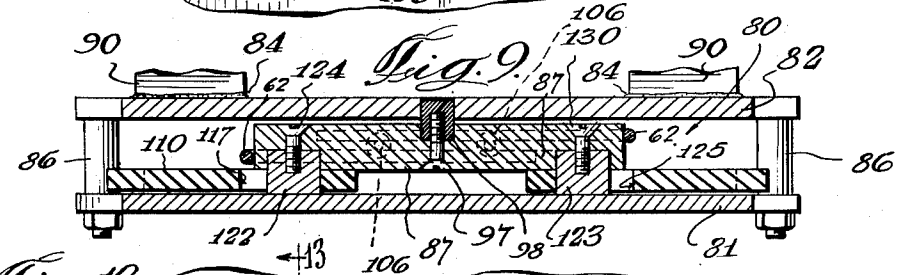


Fig. 9.

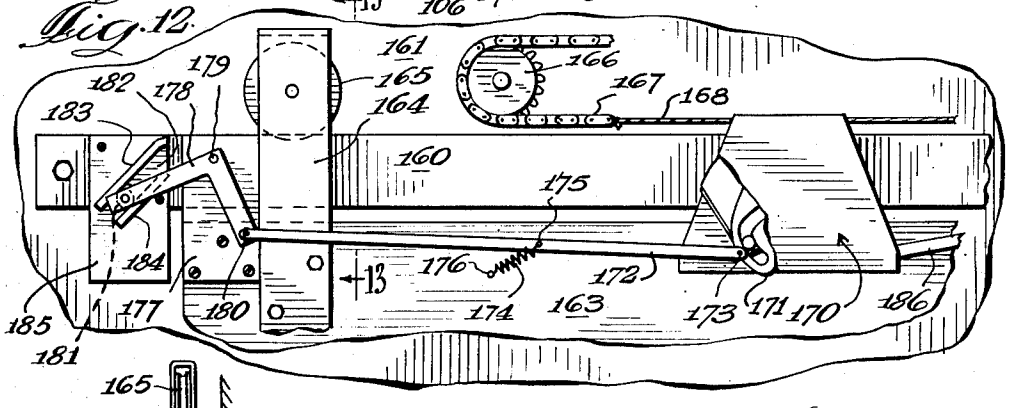


Fig. 12.

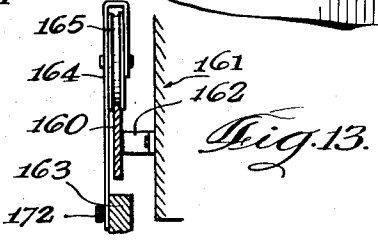


Fig. 13.

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UNITED STATES PATENT OFFICE

2,653,022

ANTIINERTIA MECHANISM FOR SLIDING DOORS

Westropp Armstrong, Glen Ellyn, Ill.

Application July 3, 1951, Serial No. 234,955

22 Claims. (Cl. 268—49)

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This invention relates generally to sliding doors and more particularly is concerned with a mechanism for compensating for the inertia of sliding doors both at the time of stopping and starting the movement thereof.

The problems caused by inertia of sliding members such as doors or panels is principally of importance in the case of installations where the sliding members are of great weight. For example, large commercial establishments such as warehouses and other material storage and handling places use large doors, both for securing ingress to and egress from the structure, and as well for maintaining a constant separation between various sections of the structure. The latter type of doors are usually of the horizontal sliding type and are known as fire doors, and their purpose of course is obvious.

In such sliding members, the larger the door, the more power is required to operate the same and the more desirable it is to have as little frictional resistance as possible. In such cases (but also to a lesser degree in the smaller door installations), the inertia acquired by the doors while moving is considerable, and unless otherwise prevented from doing so, the doors violently collide with one another during closing, or with the mechanical door stops during opening. Such collisions besides being annoyingly noisy, result in damage to the installation in many ways such as for example: deformation and deterioration of the doors, the door tracks and cables, the stop means; breakage of parts; and unusual wear on all parts. Of equal importance are the common effects of the door wheels jumping out of or becoming jammed in the tracks, delay caused by inoperativeness of the installation, and the bouncing of the sliding doors at the end of their intended extent of travel. This latter mentioned difficulty results in the doors remaining partially open or partially closed although they should be totally open in the first case and totally closed in the second case.

Thus far I have described the matter of halting the movement of the doors and the problems encountered by reason of a large mass acquiring a substantially constant velocity and suddenly having that velocity become zero. Obviously there is considerable kinetic energy which must somehow be absorbed or dissipated. In addition to these problems there is the matter of starting these doors. It requires considerable energy to bring the velocity of the large mass from zero suddenly up to the normal speed at which it is intended that these doors move. Once the initial

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friction has been overcome the door will suddenly surge forward giving rise to a great jerk whose deleterious effects are quite similar to those mentioned in connection with stopping the doors. There is a great strain placed upon the operating mechanism and apparatus, and deformation, damage, and the like are also not uncommon results of such jerking.

Many mechanisms heretofore have been devised for absorbing or counteracting the inertia of such large bodies as described, both in starting and stopping the same, but none have been satisfactory. Such devices have included dashpot systems, springs, and friction brakes, but none of these expedients has been successful to the best of my knowledge. In particular, none of these mechanisms has been useful both in starting and stopping sliding doors, and none is positive acting, and gives uniform results irrespective of the temperature, humidity, and many other variable conditions to which such installations are subjected. None of these mechanisms used have enabled the door to be brought to a gradual and positive stop at each end of its path of travel.

The principal object of my invention is to provide a mechanism which will alleviate the difficulties and solve the problems set forth above. Specifically the principal object is to provide a positive acting mechanism which will enable doors (or other sliding bodies) to start smoothly and stop smoothly; which will enable such bodies to come to a positive yet smooth stop in the same position regardless of the temperature, humidity, speed of travel, and age of the installation; which will not require the use of dash-pots, brakes, clutches, or bumper springs.

Another object of the invention is to provide a mechanism for use as an anti-inertia device in connection with sliding bodies such as bi-parting, horizontally sliding doors, in which the doors will start or stop with substantially simple harmonic motion, although the doors travel normally at a substantially constant velocity. The described motion is not intended as a limitation, but merely to state that the door motion in starting is at first very slow, then increases in velocity, until it reaches the velocity of the cable, with the reverse process occurring during the stopping movement of the doors.

Still another object of the invention is to provide a device of the character described which comprises a mechanism capable of readily being installed upon a movable door or panel for cooperation with a rectilinearly moving chain or

cable secured to the door and adapted to be moved to open or close the door.

A further object of the invention is to provide a mechanism for absorbing the initial jerk of a cable-actuated sliding door and for absorbing the final sudden stop thereof by enabling the cable to move relative to the door at the beginning and end of the path of movement of the door, but which automatically and positively will lock the cable or chain to the door during the constant velocity travel thereof along the said path between starting and stopping.

Still another object of the invention is to provide a device of the character described which is extremely simple and made up of a minimum of easily fabricated parts; in which there is substantially no wear on the parts; in which no electrical or hydraulic elements are required; and which may be made extremely rugged and durable, yet be small in volume of space occupied.

Many other objects of the invention will become apparent as a detailed description of the invention proceeds, in which I have described by way of illustration and elucidation (and not by way of limitation), preferred embodiments of the invention to carefully set forth the manner in which the invention is used and constructed to carry out the objects of the invention.

In the figures in which like or similar parts are represented by the same characters of reference throughout the several figures of the drawings:

Fig. 1 is a front elevational view showing the principal components of an installation of sliding doors having associated therewith an anti-inertia device constructed in accordance with my invention, and showing the doors in a closed condition.

Fig. 2 is a view similar to that of Fig. 1 but illustrating only part of the installation, and showing the doors partially open.

Fig. 3 is an elevational view on an enlarged scale of the left hand end of the installation illustrated in Figs. 1 and 2, but with the doors being fully open, and thus illustrating the left hand door and the anti-inertia mechanism secured thereto, the front cover plate of said mechanism having been removed.

Fig. 4 is a sectional view taken generally along the line 4—4 of Fig. 3 and in the indicated direction.

Fig. 5 is a sectional view taken through the anti-inertia device along the line 5—5 of Fig. 4 and in the indicated direction.

Fig. 6 is a sectional view taken generally along the line 6—6 of Fig. 1 and in the indicated direction.

Fig. 7 is a sectional view taken along the line 7—7 of Fig. 3 and in the indicated direction.

Fig. 8 is an elevational view on an enlarged scale of the anti-inertia device as disposed in Fig. 2, the front cover having been removed to show the constructional details thereof.

Fig. 9 is a sectional view taken through the anti-inertia device along the line 9—9 of Fig. 8 and in the indicated direction.

Fig. 10 is a sectional view taken through the roller and guide of Fig. 3 along the line 10—10 and in the indicated direction.

Fig. 11 is a perspective view of the rotatable segment of the anti-inertia device.

Fig. 12 is a view similar to that of Fig. 3 but showing a simplified door installation and a modified form of the invention.

Fig. 13 is a sectional view along the line 13—13 of Fig. 12 and in the indicated direction.

Fig. 14 is a semi-diagrammatical elevational view of parts of a modified form of the invention.

As previously set forth, the invention is intended to prevent the jerking in starting the movement of a sliding body, and the shock occurring through sudden stopping thereof. It is to be understood that the invention is applicable to doors, panels, wall sections, or any other sliding body of relatively large mass, and that such bodies may be arranged to move horizontally or vertically. It is desired to point out that the fact that the illustrated embodiment is associated with a pair of bi-parting, horizontally sliding doors is not intended to limit the invention to such use, or even to use with a pair of doors. The mechanism is as equally suited for use with a single sliding door or other sliding body.

Considering now the particular construction illustrated there is shown a wall partition having an opening which is adapted to be closed by a pair of bi-parting sliding doors. The doors run on tracks arranged above the opening and slide in opposite directions relative to each other. A driving mechanism is provided to drive a cable or chain about sheaves or pulleys and having one of the sliding doors secured to one reach of the loop to move rectilinearly with the reach when the loop is driven. A second loop is provided independently mounted, and having one door secured to one reach thereof and the second door secured to the second reach thereof so that the doors are counter-acting. In the case of vertically sliding doors, the doors would thus be counterbalancing.

The anti-inertia mechanism is associated with the door first driven by the driving mechanism, although in a system of this kind the second door could as easily have the said mechanism associated therewith. The conjoined ends forming the first driven loop (distinguished by this designation from the second or counter-acting loop) meet at the place where the loop reach is secured to the first door. However, instead of a conventional securement, I provide a segment of a pulley, with the axis thereof perpendicular to the line of movement of the door, and with its plane preferably (although not necessarily) parallel to the plane of the door. The free ends of the loop cross along one portion of the peripheral edge of the segment and are secured to the segment on opposite sides thereof, so that pulling the reach in one direction tends to rotate the pulley segment so that the said peripheral edge tends to rotate towards that direction; and pulling the reach in the other direction has the opposite effect.

The segment is associated with a camming mechanism in a manner to be described in detail, which renders the segment non-rotatable during the time the doors are travelling between their open and closed positions, so that the driven loop acts directly upon the first door. At the beginning and end of the path, the mechanism locking the segment against rotation relative to the door and driven loop is rendered ineffective by means which is dependent upon the distance of the door from said means, so that the segment becomes capable of limited rotation at these times. Rotation of the segment is opposed by spring means, but said opposition is readily overcome and is provided only to effect recovery of the segment

to erect position in certain cases, as will be described. In the preferred embodiment the spring is necessary only to keep the segment erect and not to help it achieve that position. The effect of the segment being able to rotate at the beginning and end of the movement of the door is as follows: in starting, the initial jerk of the loop will be utilized in rotating the segment from a substantially free to a locked erect condition with respect to the door, but the locked condition is attained only when the door has moved away from its position of rest and has begun to travel at normal movement velocity, and hence the door will start slowly and smoothly to move as more and more pulling power is made available to it; and in stopping, the inertia of the moving mass is first dissipated when the segment begins to rotate so that the speed of the drive cable may remain constant until the end of the movement, but the stopping effect thereof is felt by the door at a gradually increasing and smooth rate which may be substantially simple harmonic in nature. The travel of the cable in stopping will be well beyond the ordinary point of securement thereof to the door, but this results in a rotation of the segment to an unlocked condition in which it remains until after the door is started from rest position once more. It is pointed out that the "locked" and "unlocked" positions referred to are the erect and rotated positions of the segment relative to the door. It should be remembered that in its rotated positions, the segment causes the door to be substantially locked against movement relative to the wall.

Referring now to the constructional details illustrated, the reference character **20** designates generally a wall of any suitable construction having a conventional rectangular opening **21** which is closed off by a pair of biparting horizontally sliding doors. The doors are designated as the first door **22** shown on the left in Fig. 1, and the second door **23** shown on the right in Fig. 1. Each of the doors is formed in any suitable fashion well-known in the art, such as for example, as shown in Fig. 7, wherein the door **22** has a rectangular sheet metal panel **24** reinforced and framed by angle iron members **25** suitably bolted in assembly by bolts **26**. Obviously the door could be formed of wood, or laminated with fireproof material or the like. It should be appreciated that the doors **22** and **23** will have considerable mass.

Each of the doors **22** and **23** has a pair of hangers **30** (see Fig. 7) having a cross bar **31** at the bottom thereof bolted as at **32** to the upper edges of the respective doors, and having a stub shaft **33** journalled in the upper end thereof. The stub shaft has a pair of freely rotatable wheels **34** mounted thereon on opposite ends with the hanger secured in the center between the wheels. A box track **35** extends along the upper edge of the opening **21**, being secured to the wall **20** by suitable brackets **36** bolted to the wall as at **37** and secured to the box track as for example by welding, as shown at **38**. The box track **35** has a generally rectangular cross-sectional configuration with a longitudinal slot **40** in the bottom thereof of a width sufficient freely to accommodate the hanger **30**. The wheels **34** are thus disposed internally of the box track and ride upon the bottom thereof.

Three of the brackets **36** are illustrated in the drawings, and their construction is identical, except that the two outer placed of these brackets each have a sprocket wheel **41** journalled upon a stub shaft **42** secured to a socket **43** which in turn is mounted to the rear of the brackets. A chain or cable **44** is engaged in an endless loop over these sprocket wheels **41** having an upper reach **45** and a lower reach **46**. Each door has an extension as shown at **47** and **48** in Fig. 1, secured at the upper meeting corners of the respective doors, and the extensions are respectively secured to the reaches **45** and **46** to move therewith. Obviously, when the first door **22** moves to the left it causes the second door **23** to counter-act and move to the right, and vice versa.

The box track **35** has a bracket **50** bolted to the front thereof at the left hand end thereof as viewed in Fig. 1 to provide bearing support for a shaft **51** as shown in Fig. 4. Shims **52** may be provided for adequate journal surface. The shaft **51** extends through the box track **35** and out the rear thereof. To the front of the shaft there is mounted a sprocket wheel **54** and to the rear of the shaft is secured another sprocket wheel **55**. There is a bracket **56** and sprocket wheel **57** similar to bracket **50** and wheel **54** respectively, secured to the right hand end of the box track **35**, but having no additional wheel similar to **55**. A flexible driving element is looped over the two wheels **54** and **57**, and the first door **22** is secured to the bottom reach of this element. The element can be any cable, or chain or belt, but in the illustrated embodiment, it is conveniently and economically made up of a length of sprocket chain **60** on each end of the loop to engage the respective sprocket wheels, and give positive drive, and lengths of flexible cable, **61** and **62** secured to the chain ends as for example at **63**.

Adjacent to the left hand end of the box track **35** there is provided a suitably supported platform secured by bracket **71** to the wall **20**. The platform **70** supports the driving means for moving the doors. Same includes an electric motor **72** having a shaft **73** driving a worm **74** and pinion **75** in the gear reduction unit **76**. Obviously any suitable speed reducing means and prime driver can be used. Likewise, it has not been deemed necessary to illustrate further and describe the shaft couplings and conventional details. A suitable brake mechanism is shown symbolically at **77**. The pinion **75** drives a sprocket wheel **78** and a sprocket chain **79** engages over wheel **78** and wheel **55**. When the motor **72** is energized, the driving mechanism will rotate the loop including cables **61** and **62** thereby sliding the door **22** right or left as the case may be, since the door is secured to cable **62** as will be explained.

Electrical controls and connections are not shown since same are capable of assuming many different forms.

As thus far described, the installation is substantially the same as any conventional sliding door arrangement which utilizes the same or similar features. There is no provision, as thus far described, which will prevent the doors from crashing together upon closing or crashing against their respective stops upon opening. There is no provision for preventing starting jerk from occurring as the doors pass from rest to moving condition. More important, there is no provision for enabling the doors gradually to come to a stop from their moving condition during the last phases of movement and coming to rest at substantially the identical position upon every cycle of movement thereof. These things are accomplished only by the invention which will hereinafter be described.

Mounted in the upper left hand corner of the door 22 is a mechanism, designated generally by the reference character 80 which will enable the accomplishment of the advantages mentioned. These are a cushioning of the doors during stopping, the gradual increasing of the velocity of the doors during starting to prevent jerking, the stopping of the doors at the end of travel at predetermined points. The anti-inertia device 80 is best illustrated in Figs. 3, 5, 8, and 9. The movable parts of said device are mounted between front and rear generally triangular shaped plates 81 and 82, the rear plate 81 being secured to the front of the door 24 in any suitable manner such as by welding as shown at 84 to assure that the device will move with the door. It is emphasized that the only connection between both doors and the lower cable 62 is achieved by way of the device 80 and no external stop members are provided for the doors. The plates 81 and 82 are spaced one from the other by spacers 86 bolted at the lower corners thereof.

In order to provide for mounting of the device 80 upon the door 22 the upper angle iron 25 may be cut away as at 89 and the welds 84 may secure angle brackets 90 to the rear of the plate 82 which brackets may be bolted as at 91 to the angle iron 25. At the lower end of the plate 82 there may be provided a nut 92 welded as at 93 to the rear thereof, for receiving a bolt 94 therein. A stand-off spacer 95 is provided through which the bolt 94 secures the lower end of the device 80 to the door 22.

The rear plate 82 has mounted thereon a rotatable pulley segment 87 having a grooved upper edge 88 (see Fig. 11) curved about the center of rotation of the said segment. The segment 87 is generally of keystone formation and is pivoted upon a bolt 97 mounted on a bushing 98 which is inserted in the rear plate 82. A suitable anti-friction washer 99 may be provided. As will be noted the lower cable member 62 is actually formed of two parts, each of which is crossed about the keystone-shaped pulley segment and secured thereto. Thus, there is one end designated 62' which passes over the grooved edge 88 from left to right as viewed in Figs. 8 and 11, and thence passes down the right hand edge 101 of the segment 87 and round the bottom edge 102 where it terminates. The end designated 62'' passes over the pulley edge 88 from right to left, down the left side 103, and around to the bottom 102 where it also terminates. Both ends are secured to the bottom edge 102 by any suitable means such as clamp washers 105 held in place by simple screws 106. Any other securement means is suitable. The ends 62' and 62'' are secured with the cable 62 taut by means of turnbuckles (not shown) for example.

As thus far described, it will be appreciated that if the keystone shaped pulley segment 87 is freely rotatable, but limited in its extent of rotation, say through thirty or forty degrees (not considering any other part of the mechanism which will be described) then, from an upright position of said segment, if the cable 62 is moved either right or left, before the door 24 will commence to move, the segment 87 must rotate through the extent available.

This rotation of the segment relative to the door, so that there is movement of the cable relative to the door prior to movement of the door, is an important principle used in achieving the results alluded to herein. Obviously there is means provided to control the rotation or absence of rotation of the pulley segment which will now be described.

I provide a pair of cam members 110 and 111 disposed between the segment 87 and one of the plates. In the embodiment illustrated the cam members are adapted for movement between the segment 87 and the front plate 81. The cam members are pivotally mounted at the top of the device 80 at 112 and 113 respectively. Each member has certain cam ways which will be described, for cooperation with the pulley segment 87. As viewed in Fig. 8, the major portions of the cam members extend downward and over the pulley segment. It should be appreciated that the pulley segment could be mounted on the front plate and the cam members mounted between it and the rear plate, but this arrangement is obvious, and need not further be discussed, especially since it makes no difference in the operation of the device.

The cam member 110 is intended to rotate about its pivot 112 from its erected position as shown in Fig. 8 to the position shown in Fig. 3 in a counter-clockwise direction at the left hand end of the path of movement of the door 22. Likewise the cam member 111 is intended to rotate from the position shown in Fig. 8 to a position similar to that of cam member 110 in Fig. 3, albeit a mirror position thereof and not shown in the drawings, when the door 22 has reached its extreme right hand end of its path of movement. During the rotation of the respective cam members as described there may be a slight movement of the opposite cam which is of no importance. In the preferred embodiment first described, the pivotal movements of the cam members 110 and 111 at the ends of the path of the door 22 is positive and forced, both while the door is approaching that end and leaving that end, but in another embodiment which will be described, recovery of the respective cam members to erect position is effected by spring biasing means. Thus, in the latter referred to variation of the structure, the cam members 110 and 111 are biased to rotate in clockwise and counter-clockwise directions respectively.

Referring now to Figs. 3 and 8, a coiled spring 114 is shown connected between eyes 115 and 116 of the respective cam members. In the preferred embodiment, this spring 114 is a mere refinement and intended for holding the cam members 110 and 111 erect and firm against play. In the modified form (i. e., where the paths of movement of the cams are not positively confined and determined by certain track means in a manner which will be described) the said spring 114 would serve as means for biasing the cam members 110 and 111 to recover their erect positions after the door has left a position of rest. This will be explained fully hereinafter in connection with Fig. 14. Other biasing means will also be described.

Considering now the left hand cam member 110, there is provided a cam way therein in the form of a slot 117 whose shape is irregular. The slot has three parts, all connected together in such a manner that a cam can pass smoothly throughout the entire extent of the slot 117. There is an upper arcuate portion 118 whose center of curvature is the pivot 97 of the pulley segment 87 when the device 80 is in the condition shown in Fig. 8. At its lower end, the upper arcuate portion 118 connects with a rectilinear

portion 119 which extends at an oblique angle therefrom downwardly and to the left, the juncture between the two portions being designated 120. The lower end of the portion 119 connects with a lower arcuate portion 121 whose center of curvature is generally in the vicinity of the center of the pulley segment 87. Actually, in the circumstance that the lower arcuate portion 121 is in use, the mechanism is so arranged that the center of curvature of said arcuate portion 121 is the pivot 97, as illustrated in Fig. 3.

The pulley segment 87 is provided on its front surface with dowels or pins 122 and 123, the first of which is engaged in the slot 117 and acts as a cam therefor. The dowel 122 is held against the pulley segment 87 by the screw 124.

It will be noted that the cam members 110 and 111 are of irregular shape, and it is desired to point out that the shape is immaterial so long as the paths for movement of the dowels or pins 122 and 123 are provided.

Referring now to the right hand cam member 111 and its pin or cam 123, the construction thereof is identical to that described for the cam member 110 and its pin 122. Thus there is a slot 125, upper arcuate portion 126, juncture 127, rectilinear portion 128, lower arcuate portion 129, and the pin 123 is held in place by the screw 130. The difference between the members 110 and 111 is that they each face in opposite directions from one another.

The additional constructional features of the device 80 will for the moment be disregarded, and the operation of that part thus for described will be set forth in detail. In Fig. 8 there is illustrated a condition in which the door 22 is moving, either to the right or to the left. In other words, its velocity is equal to the velocity at which the cable 62 is being moved. The tendency of the cable to rotate the segment 87 is resisted because the cam pins 122 and 123 are positioned in the junctures 120 and 127 respectively. The cam members 110 and 111 in this position will be considered erect. Tendency of the pulley segment 87 to rotate in a clockwise direction is opposed by the cam pin 123 bearing against the lower edge of the juncture 127. Since the movement which would be required of the cam pin 123 is at right angles to the radius of the upper arcuate portion 126 from the pivot 97 to the pin 123, and the line of this movement practically passes through the pivot 113 of the cam member 111, there can be no moment given to the cam. In addition, the bias of the spring 114, although quite small, is sufficient effectively to lock the cam member 11, and hence the pulley segment 87 against movement.

Summarizing, in the condition illustrated in Fig. 8, the device 80 is locked against rotative movement, and the cable 62 is secured to the door and moves therewith. This situation prevails while the door is between its limits of movement, i. e., when the cable 62 is being driven at a constant velocity.

It becomes apparent, that in order to unlock the anti-inertia device, it will be required to swing the cam members 110 or 111 inwardly, i. e., against the bias of the spring 114. Two expedients are illustrated for accomplishing this function, one being illustrated in the embodiment of Figs. 1 to 10 inclusive and the modified form of Figs. 12 and 13, and the other being illustrated in Fig. 14, the keystone shaped pulley segment 87 is substantially the same in both cases. The modified form of Figs. 12 and 13, although slightly different, operate on the same principles as the embodiment of Figs. 1 to 10.

In order to unlock the anti-inertia device 80, i. e., render same operative, means must be provided which operate as the door 24 approaches a position of rest. Furthermore, the same or other means must be provided which render the device operable as the door leaves its position of rest. To accomplish these functions, I provide the cam members 110 and 111 with extensions 140 and 141 respectively, in the form of integrally formed elongate arms extending upwardly and to the right or left as the case may be. The ends of the extensions are provided with free rollers 142 and 143 respectively mounted thereon in any suitable fashion. The box track 35 at the left hand end thereof is provided with a pair of metal strips 144 and 145 welded or otherwise secured to the front member of the box track and arranged parallel one to the other. They form a channel or track 146 which slants downwardly and to the left as viewed in Fig. 3 in the path of the roller 142 as it moves to the left with the door. Since the roller 142 is moving rectilinearly when the door 24 is moving to the left, when said roller 142 enters the track 146 it will be positively guided downwardly and to the left as the door 22 continues to move to the left. This movement will now rotate the cam member 110 in a counterclockwise direction. This movement is against the bias of the spring 114 which, as has been explained, is not essential to the operation of the device. As this occurs, the anti-inertia device becomes unlocked from the door, i. e., the pulley segment 87 becomes free to rotate. The inertia of the door 22 is cushioned as the door operates the limit switch 147, and comes to a stop.

This action occurs in two steps which occur either simultaneously or in overlapped relation. The rotation of cam member 110 first causes the cam pin 122 to leave the juncture 120 and begin to follow the straight slot portion 119. The pulley segment 87 will begin to rotate in a counterclockwise direction about the pivot 97, but not a great deal. At the same time, the opposite cam pin 123 begins to travel up the arcuate portion 126. The cable 62 now begins to move a slight amount to the left relative to the door 22. Since the cable is travelling at a constant velocity, this relative movement gives rise to a slowing down of the door. The cam pin 122 continues to move down the slot 119, slowing the door's velocity. The relative movement between the cable 62 and the door continues as the pulley segment rotates giving rise to this phenomenon. Obviously, since the portion 119 is straight, the rotation of the cam member 110 at a constant speed will increase the speed of rotation of the pulley segment 87 until the end of the portion 119 is reached. The arm 110 stops rotating at this point, although the segment 87 is free to rotate. The instant that the cam pin 122 enters the lower arcuate slot 121 the arm 110 cannot rotate because if it does the pin 122 must move in a direction perpendicular to a line drawn from the pivot point 112 through the pin. The only time that this was possible was when the pin 122 was in the rectilinear portion 119 of the cam way 117. Therefore, since the pivot point 112 is fixed relative to the door 22, the fact that the cam member 110 cannot move when the pin 122 enters the slot 121 forces the door positively to stop. By adjustment of the relative arrangement of the various parts, i. e., the positions of the device 80, the track 46, and the door 22 with

respect to the opening 21, the precise position at which the door is to stop can be determined. Furthermore, this position can be kept at the identical point for every cycle of door movement within the limits afforded by the play of the mechanism. It is a relatively simple matter to have this point remain within a one-sixteenth of an inch variation for the larger type of fire door installation.

After the door has stopped moving to the left, as is the situation in Fig. 3, the segment 87 is still free to rotate, and in this case, the cam pin 122 rides down the lower arcuate slot 121 while the opposite cam pin 123 rides up the slot 126. This permits the cable 62 to continue moving for a short distance while the motor 72 is braked to a stop. The limit switch de-energizing the motor 72 may be adjusted to shut off the power just before the roller 42 enters the track 146 or may be set any time before or after. It is preferred that the cable 62 come to rest before the pin 122 engages the termination of the arcuate portion 121. It will be obvious, however, that regardless of where the pin 122 stops its movement relative to the arcuate portion 121, the door 22 will stop its movement at the same point relative to the opening 21. This makes for perfect, positive, and gradual stopping regardless of many conditions which would affect other methods of stopping the doors, such as humidity, temperature, frictional variations, play in the driving mechanism, etc.

It should be appreciated that the device 80 need not have two cam members to give the desired results, considering only one end of the travel of the door. In other words, the cam member 110 and pin 122 act to cushion the door 22 at the left end of its travel and absorb the jerking when the door starts off from left rest position toward the right. If the right hand end of the door were cushioned in some other fashion and jerking prevented in another way, the cam member 111 and pin 123 would be unnecessary and could be eliminated. In their place there could be some simple stop mechanism to prevent clockwise rotation of segment 87. Since, however, it is best to provide anti-inertia means at both ends of the travel path, the second cam member is needed. Likewise, for a single action anti-inertia device, the upper arcuate slots 118 and 126 would not be required.

Referring once more to Fig. 3, let us presume that the cam pin 122 has moved to a halt in the lower arcuate portion 121, and the cam pin 123 has moved adjacent the upper end of the arcuate portion 126 of the slot 125. The door 22 is at rest at the left end of its travel path. When the motor 72 is energized, it reaches constant speed almost at once. This would normally cause the cable 62 to start the door 22 moving to the right with a jerk. However, because of the anti-inertia device 80, the inertia of the door is not permitted to oppose movement of the cable 62 to the right.

When the cable begins to move, it starts rotating the pulley segment 87 in a clockwise direction. First the pin 122 travels up the arcuate slot portion 121 without affecting the cam member 110 and without moving the door. Next the cam pin 122 enters the slot portion 119 and begins to rotate the arm 110 clockwise about the pivot 112, pulling the roller 142 up the track 146 and thus moving the door forward. As the arm 110 moves from its position above described to that of Fig. 8, the segment 87 rotates at a decreasing rate of rotation until it stops at the position shown in Fig. 8, and being unable to travel further, locks the cable 62 to the door 22. Thus the speed of the door 22 has gradually increased until it is equal to the speed of the cable 62.

Obviously the same operations described for stopping the door occur, albeit in an opposite direction, when the door reaches the right hand end of its travel path. The roller 143 enters track 150 formed between strips 151 and 152 to cushion the door 22. Jerking during starting also is prevented in the manner described. In this last mentioned case, the segment 87 rotates counter-clockwise.

The parts of the anti-inertia device referred to as cam members 110 and 111 have been described as having the extensions 140 and 141 for cooperation with the tracks 146 and 150 to rotate the respective cam members in the manner set forth above. Obviously, any means capable of causing the rotation is equivalent. For example, in Fig. 14 I have diagrammatically shown a cam member 210 pivoted at 212 and having a biasing spring 214 tending to rotate same in a clockwise direction. The remainder of the anti-inertia device need not be illustrated since its construction is obviously the same as the device 80 (except that the opposite cam member is like 210). Note that the extensions 140 and 141 have no counterpart here. Instead, there is a fixed member 240 which is secured to a wall or the like and which is aligned with the cam member 210 so that when the door carrying the cam member 210 approaches its position of rest, the end of the member 240, which may be provided with a roller 241, engages the edge of the cam member 210 and rotates the same in a counter-clockwise direction. In this variation of the invention, the biasing spring 214 is essential in order to force recovery of the cam 210 to erect position when starting to move the door to the right.

Another manner of causing the desired rotation of the cam member is illustrated in Figs. 12 and 13. Here are shown a simple metal rail 160 secured to a wall 161 by brackets 162', a conventional door 163 having hangers 164 mounting roller wheels, one of which is shown at 165 for rolling the door along the rail, and a driven sprocket wheel 166 and sprocket chain 167 and cable 168, the drive mechanism of which is no different from that previously described. An anti-inertia mechanism 170 is secured to the door 163 and its construction is substantially the same as the device 80 with the exception of the absence of the extension arms 140 and 141. Instead, the cam member 171 (which is the equivalent of the cam member 110) has an elongate push rod 172 pivotally mounted thereto at 173. The bias provided in the device 80 by the spring 114 is now provided by a coil spring 174 secured to the rod at 175 and the door 163 at 176 and tending to pull the rod to the left as viewed in Fig. 12. Again, in this version, because of the track 182, the spring bias is not essential. At the upper left hand corner of the door 163 I have provided a support plate 177 to which is pivotally mounted a crank arm 178 rotatable about the pivot 179. The right arm is pivotally mounted at 180 to the left hand end of the push rod 172 while the left arm has a roller 181 which is adapted to enter and slide down the track 182 formed between the strips 183 and 184 secured to the bracket 185, which in turn is fixed to the rail 160.

The operation of the structure of Figs. 12 and 13 is identical to that of the structure previously

described and hence no further details need be set forth. The push rod and crank arm structure are duplicated on the right hand side of the door 163, of which only a part of the push rod 186 is seen in Fig. 12.

It is believed that the invention has been set forth with sufficient clarity and detail to enable one skilled in the art to which same appertains to construct and operate practical embodiments thereof. As pointed out, the device operates effectively in connection with any large moving mass, and it is unnecessary that same consist of horizontally sliding articles, but can be movable either vertically or obliquely. Likewise, many details can easily be varied both as to location and dimension without in any way departing from the spirit of the invention or the scope thereof as defined by the appended claims.

I claim:

1. An anti-inertia device for an article slidable along a path relative to a fixed structure, said article being driven by a flexible drive member linearly movable relative to the fixed structure along a path substantially parallel with said first path, a mechanical coupling between the drive member and the article so that said article is adapted to move with the drive member, said coupling being normally locked while said article is moving along said path, but becoming unlocked when said article is at an end of its path to permit limited relative movement between said article and drive member, said coupling comprising a member pivotally mounted upon said article and having said drive member connected thereto and tending to rotate the same, means preventing rotation of said pivotal member in one direction, means in the path of said pivotal member preventing rotation in the other direction but removable therefrom when said article is adjacent and at said path end.

2. An anti-inertia device for an article slidable along a path relative to a fixed structure, said article being driven by a flexible drive member linearly movable relative to the fixed structure along a path substantially parallel with said first path, a mechanical coupling between the drive member and the article so that said article is adapted to move with the drive member, said coupling being normally locked while said article is moving along said path, but becoming unlocked when said article is at an end of its path to permit limited relative movement between said article and drive member, said coupling comprising a member pivotally mounted upon said article and having said drive member connected thereto and tending to rotate the pivotal member, means preventing rotation of said pivotal member in one direction, means in the path of said pivotal member preventing rotation in the other direction but removable therefrom when said article is adjacent and at said path end, and means causing limited rotation of said pivotal member when said second mentioned rotation preventing means has been removed.

3. An anti-inertia device for an article slidable along a path relative to a fixed structure, said article being driven by a flexible drive member linearly movable relative to the fixed structure along a path substantially parallel with said first path, a pulley mounted with its pivot fixed to said article, said drive member making at least a partial loop about said pulley whereby to be effectively tangential thereto and capable of rotating the same whilst moving relative to the article, means rendering said pulley non-rotatable during a portion of the movement of said article along said path, and means rendering said pulley rotatable during other portions of movement along said path.

4. An anti-inertia device for an article slidable along a path relative to a fixed structure, said article being driven by a flexible drive member linearly movable relative to the fixed structure along a path substantially parallel with said first path, a pulley mounted with its pivot fixed to said article, said drive member making at least a partial loop about said pulley whereby to be effectively tangential thereto and capable of rotating the same whilst moving relative to the article, a pulley control member carried by said article engaged with said pulley for preventing its rotation in one direction during movement of the article along a portion of said path, and means fixed relative to said structure adapted to be engaged with said pulley control member during another portion of said path to move said control member relative to said pulley rotating said pulley thereby causing relative motion between said pulley and drive member and absorbing inertia.

5. An anti-inertia device for an article slidable along a path relative to a fixed structure, said article being driven by a flexible drive member linearly movable relative to the fixed structure along a path substantially parallel with said first path, a pulley mounted with its pivot fixed to said article, said drive member making at least a partial loop about said pulley whereby to be effectively tangential thereto and capable of rotating the same whilst moving relative to the article, a pulley control member carried by said article engaged with said pulley for preventing its rotation in one direction during movement of the article along a portion of said path, and means fixed relative to said structure adapted to be engaged with said pulley control member during another portion of said path to move said control member relative to said pulley rotating said pulley thereby causing relative motion between said pulley and drive member and absorbing inertia, said pulley and control member having cooperating cam and follower means defining said relative movement along a path permitting limited movement of said pulley control member, whereby said member will cause said article to stop moving simultaneously with cessation of movement of said pulley control member.

6. An anti-inertia device for an article slidable along a path relative to a fixed structure, said article being driven by a flexible drive member linearly movable relative to the fixed structure along a path substantially parallel with said first path, a pulley mounted with its pivot fixed to said article, said drive member making at least a partial loop about said pulley whereby to be effectively tangential thereto and capable of rotating the same whilst moving relative to the article, a pulley control member carried by said article engaged with said pulley for preventing its rotation in one direction during movement of the article along a portion of said path, and means fixed relative to said structure adapted to be engaged with said pulley control member during another portion of said path to move said control member relative to said pulley rotating said pulley thereby causing relative motion between said pulley and drive member and absorbing inertia, said pulley and control member having cooperating cam and follower means defining said relative movement along a path permitting limited movement of said pulley control member,

whereby said member will cause said article to stop moving simultaneously with cessation of movement of said pulley control member, and also permitting additional movement of said pulley after the cessation of movement of said pulley control member and article, thereby enabling additional relative movement between the drive member and the article.

7. An anti-inertia device for a large slidable door moving relative to a fixed structure and having a flexible drive member adapted to be moved parallel with the door and have the door attached thereto, comprising a pulley member pivoted on the door, the drive member making at least a partial loop around the pulley and tending to rotate the same thereby to cause relative movement between door and drive member, a cam member pivotally mounted on the door with the pivot thereof spaced from the pulley pivot and having a connection with said pulley, said connection including a follower and a defined path for the follower, said cam member and pulley being arranged during normal movement of the door with the follower and path disposed to prevent rotation of the pulley and hence relative movement between door and drive member, but with the follower movable along said defined path when the door approaches the end of its travel to cause the pulley to rotate in a direction which would carry the drive member ahead of the door thereby slowing down the door.

8. An anti-inertia device for a large slidable door moving relative to a fixed structure and having a flexible drive member adapted to be moved parallel with the door and have the door attached thereto, comprising a pulley member pivoted on the door, the drive member making at least a partial loop around the pulley and tending to rotate the same thereby to cause relative movement between door and drive member, a cam member pivotally mounted on the door with the pivot thereof spaced from the pulley pivot and having a connection with said pulley, said connection including a follower and a defined path for the follower, said cam member and pulley being arranged during normal movement of the door with the follower and path disposed to prevent rotation of the pulley and hence relative movement between door and drive member, but with the follower movable along said defined path when the door approaches the end of its travel to cause the pulley to rotate in a direction which would carry the drive member ahead of the door thereby slowing down the door, the said structure and cam member having means cooperatively engaging as the said door approaches said end and rotating same a limited extent and said follower moving along said path during said rotation in an arc having a pulley pivot at its center while moving away from the cam member pivot.

9. An anti-inertia device for a large slidable door moving relative to a fixed structure and having a flexible drive member adapted to be moved parallel with the door and have the door attached thereto, comprising a pulley member pivoted on the door, the drive member making at least a partial loop around the pulley and tending to rotate the same thereby to cause relative movement between door and drive member, a cam member pivotally mounted on the door with the pivot thereof spaced from the pulley pivot and having a connection with said pulley, said connection including a follower and a defined path for the follower, said cam member and pulley being arranged during normal movement of the door with the follower and path disposed to prevent rotation of the pulley and hence relative movement between door and drive member, but with the follower movable along said defined path when the door approaches the end of its travel to cause the pulley to rotate in a direction which would carry the drive member ahead of the door thereby slowing down the door, the said structure and cam member having means cooperatively engaging as the said door approaches said end and rotating same a limited extent and said follower moving along said path during said rotation in an arc having the pulley pivot as its center while moving away from the cam member pivot, said path including an extension engaged by the follower substantially at right angles with a line drawn through the follower and the cam member pivot whereby the cam member is prevented from further movement and the door is thus stopped.

10. An anti-inertia device for a large slidable door moving relative to a fixed structure and having a flexible drive member adapted to be moved parallel with the door and have the door attached thereto, comprising a pulley member pivoted on the door, the drive member making at least a partial loop around the pulley and tending to rotate the same thereby to cause relative movement between door and drive member, a cam member pivotally mounted on the door with the pivot thereof spaced from the pulley pivot and having a connection with said pulley, said connection including a follower and a defined path for the follower, said cam member and pulley being arranged during normal movement of the door with the follower and path disposed to prevent rotation of the pulley and hence relative movement between door and drive member, but with the follower movable along said defined path when the door approaches the end of its travel to cause the pulley to rotate in a direction which would carry the drive member ahead of the door thereby slowing down the door, the said structure and cam member having means cooperatively engaging as the said door approaches said end and rotating same a limited extent and said follower moving along said path during said rotation in an arc having the pulley pivot as its center while moving away from the cam member pivot, said path including an extension engaged by the follower substantially at right angles with a line drawn through the follower and the cam member pivot whereby the cam member is prevented from further movement and the door is thus stopped, said extension also defining an arc about the pulley pivot so that although the door has stopped the drive member may continue to move relative to the same.

11. A structure as defined in claim 8 in which the cam member is provided with means biasing same against said rotation.

12. A structure as defined in claim 8 in which the means comprises a track and track rider normally disengaged but movable relative one to the other along the way defined by the track when the door is less than a predetermined distance from said structure.

13. A structure as defined in claim 12 in which the track is carried by the structure and the rider consists of a roller carried by said cam member.

14. A structure as defined in claim 12 in which

the track is attached to said structure and there is provided a crank arm having said rider thereon and having linked connection with said cam member.

15. A structure as defined in claim 7 in which said door has a second cam member arranged opposite the first cam member and having the identical construction although arranged to be operated in the manner described in said claim for said first cam member, but only when the door approaches the end of its travel opposite to that defined in said claim.

16. A structure as defined in claim 3 in which there is a second cam member identical and opposite having identical and opposite connection and adapted to slow the door down when moving in the opposite direction, and the structure and said second member have identical cooperating means operative as the door approaches the end opposite that defined in said claim.

17. A structure as defined in claim 9 in which there is provided a second identical and opposite cam, and having a second identical and opposite connection with said pulley for slowing the door down when moving in the opposite direction, each path including an arcuate portion at the end opposite said extension arranged to accommodate movement of its follower while the pulley is rotating to carry the opposite follower towards the extension of the opposite path.

18. An anti-inertia device for a large slidable door moving relative to a fixed structure and having a flexible drive member adapted to be moved parallel with the door and have the door attached thereto, comprising a pulley member pivoted on the door, the drive member making at least a partial loop around the pulley and tending to rotate the same thereby to cause relative movement between door and drive member, a cam member pivotally mounted on the door with the pivot thereof spaced from the pulley pivot and having a connection with said pulley, said connection including a follower and a defined path for the follower, said cam member and pulley being arranged during normal movement of the door with the follower and path disposed to prevent rotation of the pulley and hence relative movement between door and drive member, but with the follower movable along said defined path when the door approaches the end of its travel to cause the pulley to rotate in a direction which would carry the drive member ahead of the door thereby slowing down the door to a position of rest, said follower and path also coming to rest at least immediately after the door has come to rest in a position enabling reverse rotation of the pulley, so that when the drive member is moved backwards, the pulley will rotate in an opposite direction, the door will move away from rest and the cam member swing to move the follower and path to a position once more locking the pulley against rotation.

19. An anti-inertia device for a large slidable door moving relative to a fixed structure and having a flexible drive member adapted to be moved parallel with the door and have the door attached thereto, comprising a pulley member pivoted on the door, the drive member making at least a partial loop around the pulley and tending to rotate the same thereby to cause relative movement between door and drive member, a cam member pivotally mounted on the door with the pivot thereof spaced from the pulley pivot and having a connection with said pulley, said connection including a follower and a defined path for the follower, said cam member and pulley being arranged during normal movement of the door with the follower and path disposed to prevent rotation of the pulley and hence relative movement between door and drive member, but with the follower movable along said defined path when the door approaches the end of its travel to cause the pulley to rotate in a direction which would carry the drive member ahead of the door thereby slowing down the door, the said structure and cam member having means cooperatively engaging as the said door approaches said end and rotating same a limited extent and said follower moving along said path during said rotation in an arc having the pulley pivot as its center while moving away from the cam member pivot, said path including an extension engaged by the follower substantially at right angles with a line drawn through the follower and the cam member pivot whereby the cam member is prevented from further movement and the door is thus stopped, said device being reversible to enable relative movement between drive member and door when the drive member is driven in an opposite direction to permit the door to start from said stopped position without jerking.

20. In combination, a sliding door, an electrically operated driving mechanism, a flexible drive member driven by said driving mechanism, a fixed structure supporting said driving mechanism and having said door movable relative thereto along a predetermined path, the flexible drive member adapted to be connected to the door to drive the same, means controlling said driving mechanism to start and stop the same, a variable coupling between the door and drive member permitting relative movement between drive member and door, but only adjacent an end of said path, means for de-energizing said driving mechanism as the door approaches said path end, and means for enabling said relative movement at the end of the path, whereby when coming to rest or starting the inertia of the door will partially be absorbed, said coupling comprising a pivoted pulley member, a cam member pivoted to the door and arranged to rotate the pulley member, said means enabling such relative movement comprising engaging means on the structure and cam which cooperate to move the cam in one direction as the door approaches said end, and in the opposite direction as the door leaves the said end.

21. In combination, a sliding door, an electrically operated driving mechanism, a flexible drive member driven by said driving mechanism, a fixed structure supporting said driving mechanism and having said door movable relative thereto along a predetermined path, the flexible drive member adapted to be connected to the door to drive the same, means controlling said driving mechanism to start and stop the same, a variable coupling between the door and drive member permitting relative movement between drive member and door, but only adjacent an end of said path, means for de-energizing said driving mechanism as the door approaches said path end, and means for enabling said relative movement at the end of the path, whereby when coming to rest or starting the inertia of the door will be partially absorbed, said coupling comprising a pivoted pulley member, a cam member pivoted to the door and arranged to rotate the pulley

member, said means enabling such relative movement comprising engaging means on the structure and cam which cooperate to move the cam in one direction as the door approaches said end, and in the opposite direction as the door leaves the said end, said cam and pulley having a slot and pin connection, the slot being of such shape to carry the pin in a path about the pulley pivot but simultaneously in a path of varying distance from the cam pivot point.

22. A combination as described in claim 21 in which the slot also has a portion which prevents further movement of the pin relative to the cam pivot point except about the same whereby positively to define the position of rest of said door.

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